

Title: Nutrition, Exercise, and Mathematics

Brief Overview:

Students will use algebraic formulas to gain an understanding of how the body stores and uses energy, how exercise affects this use.

Links to NCTM Standards:

- **Mathematics as Problem Solving**

Students will consider some ways in which we keep our bodies in balance. Using information about height, weight, and level of activity, they will arrive at ways to be more healthy and fit.

- **Mathematics as Communication**

Students will study formulas related to fitness, will manipulate data using those formulas, and will produce graphs and tables to show results. Students will communicate their findings in a letter.

- **Mathematics as Reasoning**

Students will predict the effects of increased activity on heart rate and will test their hypotheses.

- **Mathematical Connections**

Students will use mathematics as a tool to learn about health and fitness.

- **Number and Number Relationships**

Students will find their target heart rate as a percentage of their ideal maximum heart rate. Students will find their estimated daily calcium intake as a percentage of the daily value.

- **Computation and Estimation**

Students will calculate their Basal Metabolic Rate for various weights, heights and ages, will measure their pulse rate, and will compute their maximum heart rate.

- **Patterns and Functions**

Students will discuss the relationship of daily calorie requirements to height, weight and level of activity.

- **Algebra**

Students will be able to evaluate expressions to calculate Basal Metabolic Rate.

- **Statistics**

Students will display their heart rate data on a graph and organize BMR data in a table.

- **Measurement**

Students will measure their pulse rate and height.

Grade/Level:

This activity is suitable for grades 6, 7, and 8.

Duration/Length:

This activity will take 5 class periods.

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Use of a basic four function calculator
- Simple order of operations (multiplication/division and addition/subtraction)
- Constructing simple graphs
- Recording data in tables

Objectives:

- Students will be able to evaluate a simple formula using order of operations.
- Students will be able to organize and graph data using a simple graph.
- Students will be able to make decisions regarding diet and exercise, using their calculations and graphs.

Materials/Resources/Printed Materials:

- Four function calculators
- Rulers, graph paper
- Worksheets (Provided at END of unit for ease of duplication)
- A clock or watch with a sweep second hand
- Height chart in inches, or yardstick taped to the wall

Development/Procedures:

Day 1: Introduce calories.

Students will estimate their daily calorie intake.

Students will complete day one of Jumping Jacks.

Day 2: Introduce Basal Metabolic Rate (BMR).

Students will calculate BMR for people of their height, age, gender, and various weights.

Students will complete day two of Jumping Jacks.

Day 3: Introduce Target Heart Rate.

Students will calculate their Target Heart Rate.

Students will complete the table "Total Daily Calories" for different activity levels.

Students will discuss exercise versus calorie intake.

Students will complete day three of Jumping Jacks.

Day 4: Class will discuss the overall project .

Students will check to see that their graphs and tables are complete and correct.

Day 5: Students will choose one of the following:

Write a letter that uses information about calories and exercise.

Calculate and discuss Target Heart Rate and complete their graphs with a friend.

Performance Assessment:

On day 5, students will complete Assessment 1 or Assessment 2.

Extension/Follow Up

A lesson on calcium needs is included after the work on the unit, to be used if discussion of other aspects of health is desired. Similar work could be done for iron or other nutrients.

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DAY 1

When we buy food, the nutrition label lists the number of calories in each serving. This is a measure of the energy our bodies get from that food. There is another scientific meaning of the word calorie, but in this lesson we will mean a measure of food energy. The more calories we take in the more food energy we have available to use. The downside of this is that if we don't use up enough of this energy, we gain weight; and if we use up more energy (calories) than we take in, we lose weight. Our level of activity and our food intake therefore determine how much weight we gain or lose, or whether we stay a constant weight.

TASK 1:

Today you will determine roughly how many calories you take in on a typical day. We will call this your DAILY CALORIE INTAKE. Use the CALORIE COUNTS chart to list the foods that you ate yesterday. If foods are not listed, list the ones that are closest to the ones you ate. List the calories next to each food. Add the calories for each meal, and then find the total for the day.

MY DAILY CALORIE INTAKE

BREAKFAST	LUNCH	DINNER
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
TOTALS _____	_____	_____

DAILY CALORIE INTAKE = _____

- How many calories do you take in daily? _____
- How many calories are from "junk food"? _____
- How many calories are from dairy products? _____
- How many calories are from vegetables? _____

These questions are important because we also get vitamins and minerals from the foods we eat. You may wish to investigate this further. Keep your daily calorie chart so that you can use it later in this unit.

TASK 2:

We are going to monitor something that goes on in our bodies when we exercise. When we exercise our heart beats faster to give our body more blood flow and more energy. When our heart beats faster we use up more calories. We don't want our heart to beat TOO fast, however, since it might be dangerous to our health. Before we talk about how fast we want our heart to beat, we need to calculate our heartbeat in beats per minute.

In order to take your pulse, turn your palm up and place the tips of your second and index fingers, just below the thumb. You will find a small depression, like a groove, on your wrist. If you press lightly you will find your pulse. When your teacher tells you to begin, count your heartbeats until your teacher tells you to stop (15 seconds). Then calculate your heartbeat per minute by using the following formula.

Beats in 15 seconds: _____ X 4 = _____ beats per minute. This number is your resting pulse rate.

Have students stand next to their desk. When you say "go" have them do TEN jumping jacks, then sit down quickly and find their pulse. Say "go" and have them count their pulse for 15 seconds, then convert that figure to a beats per minute figure and enter in the JUMPING JACKS LOG. Continue in this way throughout the week until the LOG is finished.

At home, have students do exactly the same thing they did here; except do it also with a friend. Tonight do twenty jumping jacks. The others will be done on other nights.

JUMPING JACKS LOG (pulse rate)

JUMPING JACKS	YOU	FRIEND
0 JUMPS		
10 JUMPS		
20 JUMPS		
30 JUMPS		
40 JUMPS		
50 JUMPS		

DAY 2

Today students will calculate their Basal Metabolic Rate. Even at rest our bodies are burning calories. Our heart is beating, our brain is functioning, and we are breathing. Your Basal Metabolic Rate (BMR) is the number of calories your body needs each day while at rest. The BMR does not take into account any activity. The formulas for calculating the BMR are shown below:

BASAL METABOLIC RATE

$$\text{BMR (Women)} = 655 + (4.36 \times \text{weight}) + (4.32 \times \text{height}) - (4.7 \times \text{age})$$

$$\text{BMR (Men)} = 66 + (6.22 \times \text{weight}) + (12.7 \times \text{height}) - (6.8 \times \text{age})$$

Height is in inches; weight is in pounds; age is in years.

TASK 1:

- What similarities and differences do you see in the formulas for men and women?
- Find the BMR for a woman that weighs 150 pounds, is 5 ft. 6 in. tall and is 30 years old.
- Find the BMR for a man that weighs 180 pounds, is 6 feet tall, and is 40 years old.
- Find the BMR for both a man and a woman, both of whom are 25 years old, both weigh 140 pounds, and both are 5 ft. 5 in. tall.
- Is there a difference in the BMR you calculated for the man and woman above? What do you think may account for those differences?

TASK 2:

Calculate the BMR for students the same age as you, the same gender as you, and the same height as you, but with the different weights shown in this chart.

YOUR AGE:_____ YOUR HEIGHT(INCHES)_____ YOUR GENDER_____

BMR CHART

WEIGHT	80 POUNDS	100 POUNDS	120 POUNDS	130 POUNDS
BMR				

TASK 3:

Remind students to do their thirty jumping jacks tonight with their friend.

DAY 3

Today we will discuss the concept of Total Daily Calories and the relationship between the amount of calories one burns during exercise and its effect on the weight of the body. The formula used in calculating calories' relationship to weight loss is the formula :

3500 calories burned = 1 pound of weight lost.

We will discuss different daily activity levels and how they relate to various occupations. The amount of activity can cause different people to burn different amounts of calories.

TASK 1:

We will use the BMR CHART and the ACTIVITY CHART to compare how you can burn more calories by exercising. On Day 2 students calculated their BMR and that of similar students of various weights. Using those figures and the appropriate multiplication factor have students complete the TOTAL DAILY CALORIES for various levels of activity. Use calculators.

ACTIVITY CHART

Multiply the BMR by the appropriate activity factor listed below:

- 1.3....Lightly active (normal, everyday activity)
- 1.4.....Moderately active (exercise 3 to 4 times per week)
- 1.5.....Very Active (exercise more than 4 times per week)
- 1.6.....Extremely active (exercise 6 to 7 times per week for more than one hour each.

TOTAL DAILY CALORIES

WEIGHT	RESTING BMR	LIGHTLY ACTIVE	MODERATELY ACTIVE	VERY ACTIVE	EXTREMELY ACTIVE
130 lbs.					
120 lbs.					
100 lbs.					
80 lbs.					

TASK 2:

Now that students know how many calories they would use at different activity levels, they will use the ACTIVITY CHART to see how they could burn more calories by exercising. Have students use this chart and the CALORIES COUNTS table to answer the following questions:

- Give an example of an activity which would use the same calories as a glazed donut.
- Give an example of something you could do to use the same calories as eating three slices of pizza and having a soda.
- Make up some sample meals and decide what activities you would have to do to burn those number of calories.

ACTIVITY	CALORIES PER HOUR
DANCING	125-310
ROWING SLOWLY	180-200
COOKING	185-200
WALKING SLOWLY	210-230
CLEANING HOUSE	235-355
BRISK WALKING	250-345
GOLF	300-350
JOGGING	315-480
BIKING	315-480
TENNIS	320-400
SKATING	450-525
GARDENING	480-625
BASKETBALL	480-625
AEROBIC DANCING	480-625
SWIMMING	480-625
CROSS COUNTRY SKIING	480-625

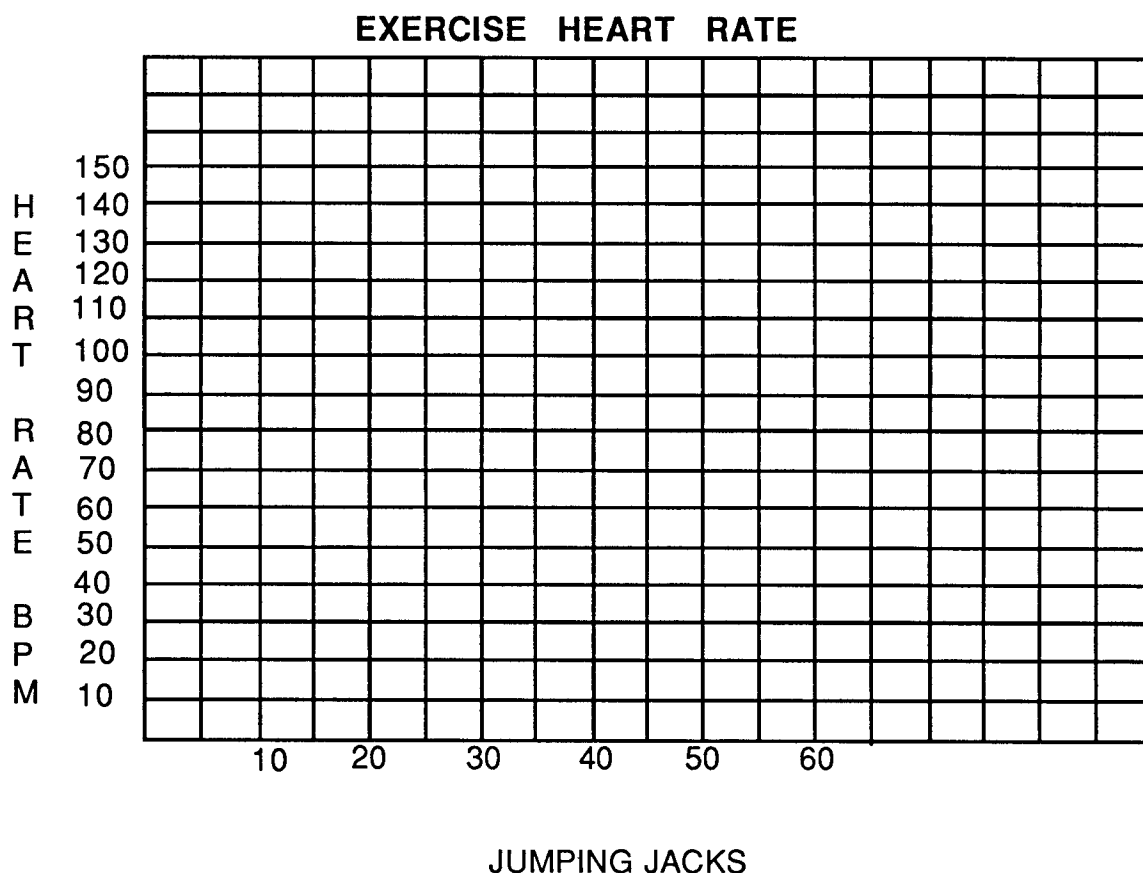
TASK 3:

Remind students to do their forty and fifty jumping jacks with their friend tonight.

DAY 4

TASK: 1

Today students will graph their heart rate verses the number of recorded jumping jacks. Next they will show that same relationship for their friend in a different color on the same graph. They are to use the data they gathered in the Jumping Jacks Log over the past three days. Have them use different colors for the two students.



TASK 2:

Have students answer the following questions using their graph.

- Does your heart rate continue to rise over the course of the five days?
- Do you think your heart rate would continue to rise if you continued this experiment for ten days? Why or why not?
- Discuss some reasons why your graph may or may not continue to rise over the five days.

DAY 5

ASSESSMENT 1:

You are completing your college degree in physical fitness. Two of your friends, Fred and Paula come to you to ask your advice on diet and fitness. Fred wishes to lose about five pounds over the next three months, and Paula wishes to gain 4 pounds during that same time period. Fred is 5 ft 8 inches tall, is 23 years old, and weighs 189 pounds. Paula is 5 feet 2 inches tall, 25 years old, and weighs 103 pounds. Fred is a master carpenter building houses, and Paula is finishing her last year in medical school.

Write a letter to each friend explaining how many calories you think each uses in one day, based on their weight, age, height and activity level. Be sure to include your calculations and explain why you think they use this many calories. Tell each person what they can do daily to accomplish their goals using diet alone and not changing their exercise, or using exercise alone and not changing their diet.

SCORING MATRIX FOR ASSESSMENT 1

Formulas for BMR correctly written, numbers substituted	5 (best)	4	3	2	1
Correct Activity Level Selected	5	4	3	2	1
Correct mathematical answer	5	4	3	2	1
Letter correlates exercise level and weight loss/gain.	5	4	3	2	1
Letter correlates diet and weight loss/gain	5	4	3	2	1
Letter correct in grammar/style	5	4	3	2	1

ASSESSMENT 2:

The formula for calculating the maximum heart rate (in beats per minute) for a person is:

$$M = \frac{4 (220 - A)}{5} \text{ where } A \text{ is a person's age in years and } M \text{ is in beats per minute.}$$

Using your age, calculate your maximum heart rate.

When a person does exercise it is suggested that they keep their heart rate (pulse) in the range of 70 % - 80 % of the maximum for about 20 minutes to benefit from the exercise. This range is called the Target Heart Range. Calculate this range for yourself and for your friend.

If you have not done so, complete the graph on pulse rate for you and your friend. Find the highest heart rate that you had during the five days, and that of your friend. Compare this with what you might expect from the formula above. Compare it with the target heart range. Write a short paragraph summarizing your comparisons. Include in your summary:

Did your actual (graph) heart rate come close to the maximum? If not, why do you think this might have happened?

Was your actual heart rate in the target range?

If you were to keep up the exercise for 15 or 20 minutes what do you think would happen?

SCORING MATRIX FOR ASSESSMENT 2

Student's age substituted correctly in formula	5	4	3	2	1
Formula evaluated correctly	5	4	3	2	1
Summary includes observation that actual heart rate may be different from the computed maximum	5	4	3	2	1
Summary includes observation that the number of jumping jacks affects the heart rate	5	4	3	2	1

Extension/Follow Up:

Calcium

NOTICE: This extension requires the student to get information from the Internet. Be sure to follow your school's policy on Internet access. The Internet address for the information needed is:

www.fda.gov/fdac/features

During the school year, you may notice a classmate wearing a cast. Or you may find yourself wearing one. Broken bones happen.

One of the major determinants of bone strength is bone density, and this is strongly affected by our calcium intake.

Sample Menu

Breakfast 6 pancakes with syrup and butter 40% Daily Value
(DV, see below)
1 c. orange juice 30% DV

Lunch 1 1/2 ham and cheese sandwich 42% DV
1 carrot 2%
1 carton of milk 40%
1 candy bar 8%

Dinner 1 steak
1 baked potato with butter
1 serving broccoli 6%
1 glass of soda

TOTAL FOR THE DAY.....168%

The Daily Value (DV) of a nutrient is the amount of that nutrient that should be consumed daily to maintain health, by an adult. Others, such as youth, the elderly, and new mothers may need more. The Food and Drug Administration has set the DV for calcium at 1000 mg.

To obtain the daily values for various foods, go to the Internet site listed above.

Notice that not all foods from your menu are on the list. That is because not all foods are calcium-rich.

On notebook paper, keep a record of all the foods you eat for a day, and the amounts. Now get the daily values for those foods and multiply it by the number of servings YOU ate. For example if the DV for 1 cup of milk is 40% and you drank 1.5 cups, then multiply $40 \times 1.5 = 60\%$. Then add the amounts to get your daily total.

Guess what! People ages 11 to 24 need 120% of the Daily Value for calcium.

Now, compare:

Recommended calcium: 120 % DV

Calcium in your diet: _____ %DV

Does your diet provide sufficient calcium? If your diet provides less than 120% DV, choose *foods that you eat* from the food chart and list below the foods you could add to your diet to make up the deficit.

STUDENT WORKSHEET PAGES

MY DAILY CALORIE INTAKE

BREAKFAST

LUNCH

DINNER

-----	-----	-----
-----	-----	-----
-----	-----	-----
-----	-----	-----
-----	-----	-----
-----	-----	-----

TOTALS -----

ACTIVITY	CALORIES PER HOUR
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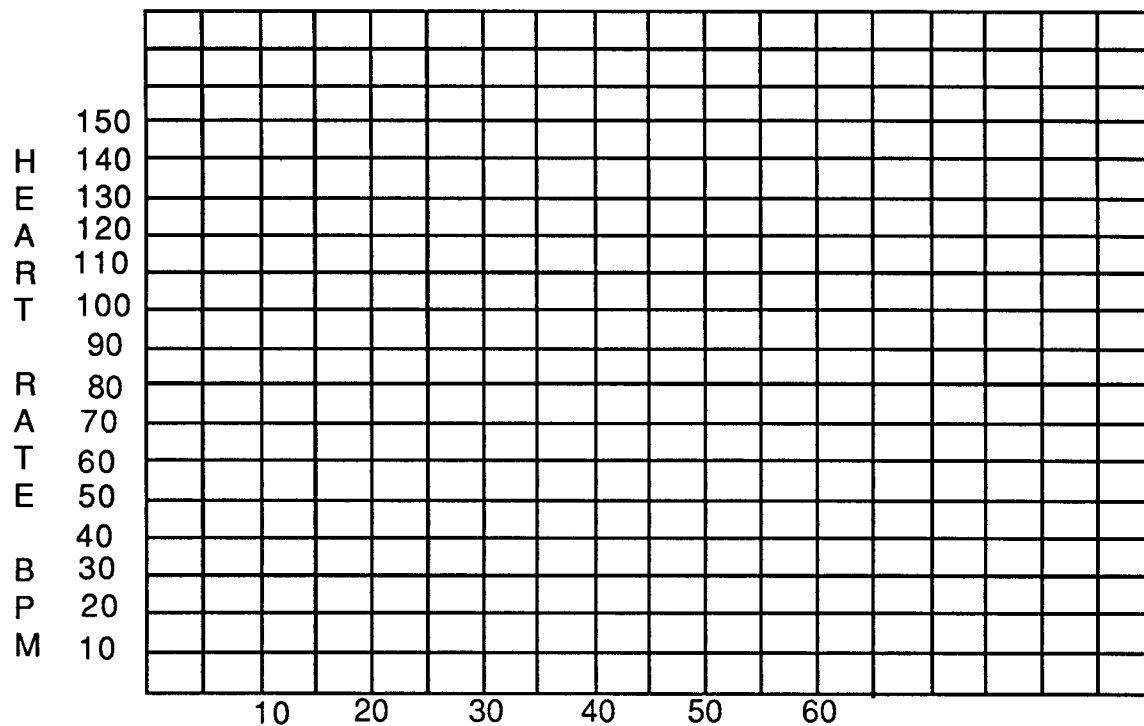
JUMPING JACKS	YOU	FRIEND
0 JUMPS		
10 JUMPS		
20 JUMPS		
30 JUMPS		
40 JUMPS		
50 JUMPS		

Pulse Rate

BMR CHART

WEIGHT	80 POUNDS	100 POUNDS	120 POUNDS	130 POUNDS
BMR				

EXERCISE HEART RATE



JUMPING JACKS

TOTAL DAILY CALORIES

WEIGHT	RESTING BMR	LIGHTLY ACTIVE	MODERATELY ACTIVE	VERY ACTIVE	EXTREMELY ACTIVE
130 lbs.					
120 lbs.					
100 lbs.					
80 lbs.					

Calorie Counts

Dunkin' Donuts

Chocolate frosted donut	200
Glazed donut	140

Kentucky Fried Chicken

Biscuit (1)	235
Chicken breast (original recipe)	283
Drumstick (original recipe)	146
Coleslaw	119
Corn on the cob	176
French fries, 1 serving	244
Mashed potatoes, 1 serv.w/ gravy	71

Domino's Pizza

Calorie amounts. are all based on the serving size of one slice of a 16 in. pizza.

Cheese pizza	188
Deluxe pizza	299
Ham pizza	208
Pepperoni pizza	230
Double cheese pizza	272
Sausage and mushroom pizza	215
Veggie pizza	249

Burger King

Whopper (1)	628
Whopper w/ cheese(1)	711
Chicken Tenders, 1 piece	34
Bacon, Egg, and Chs. Croissan'wich	355
French fries	227

Onion rings	274
Vanilla Milkshake	321

Breads

Bagel, plain	150
Blueberry muffin	112
Bread, white	68
Bread, whole wheat	67
Bun, hamburger or hot dog	119
Cornbread muffin	126
Eggo buttermilk waffle	120
English muffin	130
Hoagie roll	392
Pancake, home recipe, 4 in.	62
Pita bread, 1/2 round bread	80
Taco Shells, 1 shell--Old El Paso	55

Dairy

Butter, 1 Tbsp	100
Butter, 1 pat	36
Cheese	
American (1 slice)	100
Cheddar, 1 oz.	114
Mozzarella, 1 oz.	90
Swiss, 1 oz.	107
Cottage, 1 cup	203
Philly cream cheese, 1 oz.	100
Egg nog, 1 cup	342
Ice cream, vanilla, hard, 1 cup	269
Ice cream, vanilla, soft, 1 cup	377
Margarine, 1 Tbsp.	102
Milk, low fat, 8 fl. oz., 2%	121
Whole milk, 8 fl. oz.	150
Sour cream, 1 Tbsp.	26
Squeeze cheese, 1 oz.	82
Whipped cream, 1 cup, canned	154
Yogurt, Dannon w/ fruit, 1 cup	240

Meat

Bacon, 1 slice, 20/lb.	36
Beef bologna, 1 slice, 1 oz.	89
Beef, ground, cooked, 4 oz. regular	347
Steak, 4 oz.	240
Sausage patty	100
Ham, 1 slice, 1 oz.	52
Hot dog, beef	184
Sausage, 1 link	43
Pork chop(1) 3 oz.	294
Ravioli, 1 can	420

Dessert

Apple pie, 1 slice	250
Cherry pie	250
Chocolate cake	308
Frozen yogurt, 1 cup	200
Pound cake, 1 slice	98
Hershey's fudge topping, 1 Tbsp.	50
Pumpkin pie, 1 slice	241
Twinkies, each	160
Yellow cake, 1 slice	310

Candy

Fruit roll up	50
Granola bar	120
Hershey chocolate bar	250
Hershey kisses (9)	220
Kit Kat bar	250
M&M's, 1 pkg.	240
Peanut butter cups (2)	280
Snickers bar	275

Snacks

Doritos, one handful, 1 oz.	140
Popcorn, 1 bag, Microwave	360
Potato chips, 1 oz.	150
Pretzels, 1 oz.	110
Pringles, lunch can	420

Drinks

Coke Classic, 12 fl. oz.	144
Diet sodas	1
Sprite	142

Fruits

Apple (1 medium)	80
Banana (1 medium)	110
Cantaloupe (1/4)	50
Grapes (1 1/2 cups)	90
Orange (1 medium)	70
Pear (1 medium)	100
Peach (1 medium)	40

Vegetables

Asparagus (5 spears)	25
Broccoli (1 medium stalk)	45
Carrot (1 medium)	35
Corn (1 medium ear)	80
Green beans (3/4 cup)	25
Lettuce (1 1/2 c. shredded)	15
Potato (1 medium)	100
Tomato (1 medium)	35